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eLearning for international agriculture development: Dealing with challenges

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ABSTRACT

Agriculture, vitally important for most developing countries, must change to meet today's needs. It must produce sufficient food to feed an ever increasing global population while raising living standards of the poor and preserving the natural resource base. A key element to achieve these is to encourage the adoption of more "knowledge intensive" sustainable farming practices but this would require that farmers become more knowledgeable about the practices they employ and in how they market their production. eLearning is a potentially viable and cost-effective way to facilitate knowledge development among agricultural professionals and farmers but is still not widely employed. Many of the main challenges are known and a number of organizations have made significant progress in overcoming them. This paper focuses on how two non-profit organizations dealt with challenges associated with eLearning for agriculture and offers a number of recommendations for future efforts.

INTRODUCTION

> *"Today, farmers feed 6 billion people. However, some 800 million people go to bed hungry every night and 166 million children are malnourished. At the same time, current agricultural practices are responsible for dead zones at the mouths of the world's rivers and rapid species extinctions. By 2050, the human population will grow by two to three billion. The challenge for agriculture is not only producing more food but producing it in a sustainable manner while raising living standards for the poor, many of whom live and work in rural areas. All this must be done while dealing with the uncertain consequences of global warming and geopolitics. The solutions will include new policies, new technologies, and new production practices" (Nelson 2006)*

This assessment succinctly illustrates the current major challenges facing global agriculture and sustainable food production. Even with sufficient production of food, many go hungry. Efforts to raise production adversely affect the environment and the ability of the agricultural resource base to remain productive for future needs. The environment is changing, energy costs are rising, water resources are decreasing and competing with industrial and domestic needs. With prosperity, has come heightened customer expectations for better taste, health and nutrition and environmental stewardship from farm to table.

Underlying these situations, of course, is the ever increasing human population, expected to, "increase by 2.5 billion over the next 43 years, passing from the current 6.7 billion to 9.2 billion in 2050. This increase is equivalent to the size that the world population had in 1950 and it will be

absorbed mostly by the less developed regions, whose population is projected to rise from 5.4 billion in 2007 to 7.9 billion in 2050." (Asian Forum of Parliamentarians on Population and Development 2007)

Responding to these complex challenges will require efforts in a number of areas. Capital is critical and credit is notoriously limited for smallholder and subsistence farmers. In many countries, national policies tend to ignore the needs of rural communities in favor of urban centers and industrial enterprises. In developing countries, agricultural inputs are often hard to access, and are inferior or not available at the times needed. Water for agricultural purposes is increasingly diverted to urban areas and what is available is becoming prohibitively expensive (Abdon & Raab 2005).

While addressing these factors could have a major impact, access to information and knowledge has long been recognized as a key element for agricultural development. A key concept in the opening quote highlights the need for new policies, new technologies, and new production practices. All of these, in turn, depend to a great degree on knowledge. The importance of education and knowledge was documented as early as 1961, in a seminal work in human capital theory, Schultz observed that education explains the greater part of total factor productivity. Since then, Schultz's ideas have been substantiated by numerous studies (Lockheed, Jamison & Lau 1980; Phillips 1994; Moock 1973; 1981; and Gurgand 1993 quoted in Atchoarena & Sedel 2003).

The challenge, however, has long been in getting knowledge and information to farmers and rural communities. Leary and Berge (2006, p.51) note that a host of agricultural "problems do have workable solutions, yet the global difficulty is getting the appropriate information to farmers." The World Bank observes that "the appropriate mechanism to organize and manage research and technology dissemination for knowledge-intensive agriculture is still being debated" (quoted in Abdon & Raab 2005, p.301).

While getting the essential knowledge to those who need it most remains difficult and expensive, much optimism has been generated as a result of the increased growth and sophistication of new electronic information services—even in remote rural areas. Information and communication technologies (ICTs), and such specialized ICT applications as eLearning, are offering new options to deliver knowledge and information to farmers directly and indirectly through knowledge intermediaries. eLearning is increasingly being mentioned as a viable approach to overcome the challenges of information and knowledge delivery.

"eLearning can benefit every agricultural community around the world, from research scientists in American universities to the poor subsistence farmers of developing countries. It can benefit persons of all ages, all locations, and bridge the gaps created by mountains, deserts, oceans, wars, and political boundaries. eLearning in agriculture can assemble resources and knowledge from distant places that may otherwise be unobtainable. It can connect farmers with far away researchers and experts. It can also dramatically increase the numbers of farmers who can be reached by single training programs" (Leary & Berge 2006, p.51).

Even though the potential benefits of this approach are exciting, the adoption of eLearning for agricultural development, particularly in or for developing countries where agriculture is so critical, has been slow to take off. The challenges facing eLearning are real and well documented and pioneers in this field are experimenting and learning about approaches that can make this work. In this paper, the authors would like to share challenges they have faced in using eLearning for agriculture, what they have learned about how to make it work and what can be done to further promote its adoption.

CURRENT STATUS OF ELEARNING FOR AGRICULTURAL DEVELOPMENT

eLearning is defined in a variety of ways but perhaps the most appropriate is the one advanced by Stockley (2003). According to him, eLearning is:

> *The delivery of a learning, training or education program by electronic means. E-learning involves the use of a computer or electronic device (e.g. a mobile phone) in some way to provide training, educational or learning material.*

A quick Internet search will yield remarkably few results with eLearning opportunities related to agriculture. The majority of the links found are primarily position and research papers on pilot efforts and a few online degree programs from agricultural universities – primarily in Western countries and predominantly in the United States. Almost nothing can be found on eLearning developed or delivered by developing country organizations or targeting developing country learners.

Even looking closely at the major international agricultural development entities like the United Nations Food and Agriculture Organization (FAO) and the Consultative Group on International Agricultural Research (CGIAR), it is clear that the development and delivery of eLearning targeting agricultural producers or knowledge intermediaries is limited. Although a considerable and increasing amount of agricultural information is being made available through the Internet, online education is not.

A glance through the list of FAO's eLearning products, either developed by FAO itself or in collaboration with other agencies, indicates that the focus of their eLearning efforts is primarily agricultural policy makers and agricultural information managers. Some of the major FAO eLearning products and programs include (Nadeau & Melvin n.d., p.1):

- Information Management Resource Kit: A series of e -learning modules to build understanding and skills of individuals responsible for information management capacity at national and local levels to manage and share information
- Food Security Information for Action: A series of e -learning courses on the collection, management, analysis, and reporting of food security information. The target audience includes technical professionals as well as policy formulators and programme managers monitoring progress in poverty reduction, and meeting food security goals and targets
- The Right to Adequate Food: A series of e -learning materials are to support the progressive realization of the right to adequate food. For use by FAO and UN staff, duty bearers at national level (legislators, parliamentarians, institutions, judiciary, policy makers), as well as NGOs, civil society organizations and social movements dealing with human rights
- Enhancing Participation in Codex Activities: An e -learning course which explains the organization, management and procedures of the Codex Alimentarius Commission, and provides guidance on developing national Codex structures and activities. For government officials, as well as representatives of food industry, consumer groups, and observer organizations.

An even more esoteric eLearning program is the Joint FAO/IAEA Program on Nuclear Techniques in Food and Agriculture. This program assists Member Countries of FAO and IAEA to use nuclear techniques and related biotechnologies for developing improved strategies for sustainable food security (Joint FAO/IAEA Programme n.d.)

Like FAO, the CGIAR Centers have focused primarily on the publication of online information resources. One good example is the Rice Knowledge Bank of the International Rice Research Institute (IRRI) - http://www.knowledgebank.irri.org/. However, neither IRRI nor the other Centers offer interactive eLearning opportunities. An initial system-wide effort in this direction is the CGIAR Learning Resources Centre - http://learning.cgiar.org/ which enables centers to produce and maintain online courses where users can access a repository of CGIAR Centers' learning objects (558) and other training resources, as well as a few Web-based training courses.

Another CGIAR eLearning initiative is The Global Open Food and Agriculture University. http://www.openaguniversity.cgiar.org/index.htm. This is a program for open distance learning and capacity strengthening that serves traditional and open universities in developing and developed countries. It aims to provide resources that these universities can take advantage of to strengthen their master's degree programs in agriculture. It does not, however, deliver courses itself.

TWO ELEARNING FOR AGRICULTURE ORGANIZATIONS

While the major international agriculture organizations have made only limited efforts to develop and deliver agricultural eLearning products, a number of small, non-profit groups have attempted much more. The authors have considerable experience with two organizations focused entirely on the use of eLearning for agricultural development and these are described below.

The Asia-Pacific Regional Technology Centre (APRTC)

APRTC was an independent, non-profit organization established with the support of the International Crop Science Industry. It was dedicated to improving the welfare and knowledge of developing country farmers and the promotion of sustainable agricultural practices. A priority activity of APRTC was agLe@rn - an eLearning program taking advantage of modern information and communication technologies to address the continuing educational needs of agricultural professionals who serve and support farmers and farming communities.

APRTC began operation in early 2001 and graduated its first students in May of that year. By the time it was dissolved some 3 years later, it had made 33 offerings of 7 courses on sustainable agriculture and natural resource management which represented almost 900 learning opportunities for a widely dispersed student body. Although primarily attracting participants from developing countries in the Asia-Pacific region (86%-20 countries), agricultural professionals from other regions also signed up for and participated in agLe@rn courses (8% Africa-17 countries, 4% Latin America-9 countries, 2% Other). Alumni represented all major agricultural stakeholder groups with academics representing 40% of the total, government 20%, private sector 24% and NGOs 13%.

APRTC's portfolio consisted of 7 online courses mostly dealing with sustainable agricultural practices. The majority were related to Integrated Pest Management. "Integrated pest and weed management is often cited as one of the pillars of sustainable agriculture because it is based on sound biological principles: a multifaceted approach to pest and weed management usually makes both economic and environmental sense and is less likely to lead to the development of resistance in the target pests" (Reeves n.d.). One major course, developed in partnership with IFDC - An International Center for Soil Fertility and Agricultural Development (http://www.ifdc.org/) was focused on Integrated Soil Fertility Management. "Good nutrient management is a cornerstone of sustainable agriculture. This includes the management of both macronutrients and micronutrients, and the use of recycled farm wastes and other organic

fertilizers. Smallholders need reliable and cost effective methods, both to identify the nutrient status of crops, and to meet nutrient requirements in a sustainable way" (Food & Fertilizer Technology Center 2000).

All of APRTC's courses are archived at - http://www.sdlearn.net/APRTC/index.asp and available for browsing or use by those interested. These are:

1. Digital Literacy for Agricultural Professionals
2. Introduction to Integrated Pest Management (IPM)
3. Integrated Pest Management in Cotton
4. Integrated Pest Management in Irrigated Rice
5. Basics of Vegetable IPM
6. Responsible Pesticide Use
7. Integrated Soil Fertility Management

In an effort to find out more about participant's views on and use of APRTC's eLearning opportunities, a survey was conducted in 2003. Survey results showed that over 90 percent of APRTC alumni felt that they gained very much or much knowledge and that what they gained was worth the effort. Most (83%) were also using agLe@rn course materials and references and incorporating them in their own teaching and training activities. With only one exception, all respondents indicated that they had passed on something of what they learned in the courses to colleagues, students and/or farmers. A typical alumnus shared agLe@rn knowledge with an average of 74 other people and those who took earlier courses with many more.

Sustainable Development eLearning Network (SDLEARN)

At the end of 2003, it was decided by the International Crop Science Industry that funding would no longer be provided to APRTC. While the reasons were never explicitly stated, it appeared that there was a disconnect between corporate strategic and implementation levels. While there was an appreciation of the desirability of having better educated farmers with knowledge about sustainable agricultural practices at the more senior levels of the companies who supported APRTC's development, further down the hierarchy in these companies the desirability of this outcome was not nearly as clear. At the sales level, for example, there was a concern that widespread adoption of much of what the courses presented would negatively affect sales. As mentioned earlier, Integrated Pest Management was a key focus of APRTC's courses and this approach maintains that prevention is better than cure (i.e. synthetic chemical pesticides). (Raab 2003)

As a result, the individuals most involved with APRTC reincorporated as the Sustainable Development eLearning Network (SDLEARN) and began to secure funding from other sources. One grant, from The Asia Foundation allowed SDLEARN to carryout a project in Cambodia to establish a distance learning program at the International Institute of Cambodia. An independent evaluation of this "Provincial Business Education through the Community Information Center" project is available at - http://www.dot-com-alliance.org/newsletter/article.php?article_id=141. Another grant, from Rockefeller Foundation's Learning Across Boundaries in the Greater Mekong Sub-region (LAB) initiative allowed SDLEARN to continue to offer its sustainable agriculture related courses. Under the "Promoting human resource development for sustainable agriculture in the GMS:Taking advantage of eLearning" project, SDLEARN developed and deployed a web-based resource to promote learning and sustainable agriculture in the Greater Mekong Sub-region (GMS).

The Rockefeller Foundation project had multiple direct and indirect goals. The main focus was to provide online educational opportunities in the area of sustainable agriculture and to upgrade the knowledge and skills of agricultural educators and agricultural development practitioners living and working in the GMS. This project was also designed to give professionals in the agricultural sector a better understanding of how to use the Internet and online resources to access and evaluate relevant information, communicate with distant peers and acquire a basic skill set for life long learning.

Three online courses were implemented primarily targeting agricultural professionals and educators in the GMS. These were

- Digital Literacy for Development Professionals
- Fundamentals of Integrated Pest Management
- Fundamentals of Integrated Soil Fertility Management

By the end of the year long project, 120 learning opportunities had been accessed by a total of 95 individuals from 12 different countries. Seven students participated in 3 courses, 11 in 2 courses and 77 in just one course. Overall, 45% of the participants were women. These individuals were employed in 45 different organizations and represented a wide variety of agricultural sectors.

Students overwhelmingly indicated that they thought it was an effective way to learn and the information was useful. Most indicated that they had changed some aspect of how they went about their jobs and that they were more effective and efficient as a result of what they learned in the online courses. All thought additional online learning opportunities should be made available for their own professional continuing education as well as for upgrading the knowledge and skills of other professionals in their countries.

Course Design and Implementation

Courses in both of these organizations were constructivist in design with learners being encouraged to construct their own understanding of the topics covered. Rarely were we looking for “right” answers – just right thinking. Participants were given access to a range of online informational resources (often contradictory) and given the opportunity to critically evaluate the information and draw conclusions based on their own experience and circumstances. Learning was also supported by encouraging intensive interactive dialogue with other students in the class and comments from subject matter expert facilitators. This interaction took place in course discussion boards and email exchanges.

Unlike some constructivist courses, ours were relatively structured and linear. We found that this offered several advantages. One, it ensured that students were thinking about and discussing the same topics at the same time. Another benefit was that our students (all our participants were working adults) did not have to spend too much time thinking about what to do next. In earlier versions of these courses we had given participants more freedom to work at their own pace and on sections of their choice. The feedback we received, however, was overwhelmingly in favor of more structure.

Most of the courses were designed to run for 6 weeks. During that time, students were expected to employ a range of learning approaches including self-study, interaction with classmates and course facilitators and the submission of required assignments. The typical participant required approximately 5 hours of work per week over the time the course was offered. Each course consisted of several modules which were divided into lessons. Each module had at least one

associated assignment and most courses had a final project. All assignments and projects were given “grades” by the facilitators. The grading system used awarded all submissions either "Emerging", "Competent" or "Exemplary". Facilitators could also award an "Incomplete” for an assignment considered too unfinished. These categories were also used to give a final overall assessment which was included on the certificate.

Student Recruitment

Recruiting students and making them aware of the courses was a major activity in both organizations. APRTC employed several strategies. One was to make postings to relevant widely read listservs and online newsletters like IPMnet News published by the Integrated Plant Protection Center of Oregon State University - http://www.ipmnet.org/ . Faculty and administrative staff were also active in regional and international conferences and ran workshops for such organizations as the Asia-Pacific Association of Agricultural Research Institutions (APAARI - http://www.apaari.org/). Articles were written and submitted to a number of publications including “New Agriculturist” - http://www.new-agri.co.uk/03-3/focuson/focuson6.html and CTA's Spore bulletin **-** http://spore.cta.int. We cultivated an array of partners and “friends” with whom we agreed to exchange information and promote each other's work. A full list of our APRTC partners can be found at http://www.sdlearn.net/APRTC/partners/partners.htm and of our “friends” at - http://www.sdlearn.net/APRTC/partners/friends.htm.

In hindsight, one good source of students that was not explored but should have been was farmer and agricultural cooperatives. As these organizations continue to grow in coverage and influence, co-op managers would have been effective absorbers of eLearning services related to best agricultural practices and in an ideal position to pass on the knowledge and information directly to primary producers. For example, we have only recently learned of The International Co-operative Agricultural Organisation (ICAO) and their Website which lists contact information for leading agricultural cooperatives world wide - 11 from Africa; 7from the Americas; 12 from Asia & Pacific and 17 from Europe (http://agricoop.org/).

As SDLEARN was primarily involved in project implementation, our donors indicated the general types of institutions and learner they wanted to reach. We would follow-up with correspondence and on site visits to explain the program and recruit students. We continued, however, to use our existing methods and networks to attract students outside of the donor’s immediate target group and used organizational resources for their support.

Student Access

Students participating in our courses used a variety of ways to connect. A survey we conducted in 2003 showed that most students took advantage of Internet connected computers at work. Just over 70% of the respondents indicated that this was their most common way of accessing courses. The next most commonly used access method was local Internet or Cyber Cafes with about 25% of our students using this resource. Very few used personal computers at home and only about 3% indicated they were using this method.

One interesting finding was that there were clear differences in access methods depending on the sector in which a student was employed. The vast majority of participants in NGO’s, government offices and private sector businesses were using connections from their workplace (78%, 85% and 100% respectively). In contrast, 75% of the students from academic institutions used local Internet Cafes. The reason given was poor connectivity at work. At that time and perhaps still

true, most agricultural universities in the region had only a single shared connection for all students and faculty which drastically affected internet access speed and reliability.

CHALLENGES FACED

While the above descriptions may give the impression that delivering these courses was a relatively simple and straightforward effort, it must be made clear that a number of challenges had to be dealt with. Leary and Berge (2006) looked at the major challenges of eLearning in national and international agricultural development and their study provides a good framework for discussing the challenges we faced.

In their paper they identified the following key challenges (p.53):

- Gaps between trainers and designers.
- Challenges faced by trainers/instructors
- Challenges faced by students/farmers

Gaps between trainers and designers

Leary and Berge (2006) clearly documented deficiencies in educators' inability to bridge the technical divide. All educators face the challenge of being able to identify the knowledge and skills most needed by the students and farmers and then have considerable difficulties in presenting material in an appropriate, user friendly design so that learners can translate that information into applicable solutions on the farm. This difficulty is magnified when the medium shifts to the computer and teaching is done online.

In our experience, however, this was not a particularly serious challenge except in the very early stages. In both APRTC and SDLEARN, courses were designed by instructional designers who also had experience with agriculture and online learning. With the bulk of the design work taken care of by these professionals, instructors were able to concentrate on course facilitation and instruction.

Challenges faced by trainers/instructors

Instructors in agriculture are faced with similar challenges as those experienced by persons working in other fields. These issues include (Leary and Berge 2006, p.53):

- lack of time and skills needed in adopting new technologies
- lack of both formalized reward system and technical support
- a concern about the loss of the teacher student relationship
- marketing for programs
- financial rewards
- maximizing returns on their investment in time and money
- major increases in administrative work

We also found that trainers and instructors had difficulties switching to online teaching and major efforts were made to address these. As most of our instructors were employed in agricultural universities, we first requested permission from their employers and asked for time to be granted

for them to carry out their eLearning activities. Getting such permission was relatively easy as university administrators seemed to recognize the benefits to their institutions. While instructors did impart knowledge, they also reported that they learned much through their interactions with online students. To ensure that they had the requisite skills, newly recruited instructors were given substantial instructions before facilitating courses and consistent coaching by more experienced trainers during course delivery. Instructor efforts were rewarded both in financial terms and in the personal satisfaction they gained as a result of being able to share knowledge with an international student body. APRTC and SDLEARN were entirely responsible for marketing and much of the administrative work and instructors were allowed to concentrate exclusively on teaching and facilitation.

The loss of the teacher-student relationship was a major concern commonly voiced by facilitators and students. Several mechanisms were built in the course implementation to ensure that eLearners and facilitators could easily communicate with each other. As a result, all of our online instructors indicated that they were able to interact as well as or better than in face-to-face classrooms.

Challenges faced by students/farmers

Of the 3 challenges identified by Leary and Berge (2006), we found this to be the most serious. They correctly note that it is extremely difficult to design and market eLearning directly to farmers. Internet penetration is limited in most rural areas, computers are not available and/or affordable, material in local language is scarce and most developing country farmers lack the prerequisite computer and conventional literacy. Instead, our approach was to focus our efforts on reaching agricultural “knowledge intermediaries” - the many individuals employed by government extension systems, non-government organizations, academia, and the private sector, who have the responsibility to provide information and educational opportunities for farmers.

The other major aspect of this challenge is the difficulty of allowing for hands-on learning. One approach we employed that showed considerable promise in addressing this issue was the use of computer simulations. Computer simulations and their recreational counterpart, computer games, allow users to 'try out' aspects of the real world while controlling or easing many of the complexities that the real world represents. Main advantages of simulation are that they are engaging, cheap, fast, and safe to use, and they can be used again and again (Woods, Raab & Abdon 2002).

In an Introductory IPM course offered by both APRTC and SDLEARN, the learner is guided through a series of experiments that use the simulation as a tool to answer specific questions. For example, some simulations ask the learner to vary the strength of the pesticide, to use more than one kind of pesticide, to spray only when the pests reach a certain density, etc. The learner is also encouraged to invent new experiments and to test problems from their real-world experience using the simulation. The learner can apply dangerous amounts of pesticide season after season, run hundreds of seasons worth of experiments in a single afternoon, experience and see the results of a complex mathematical model without concerning themselves with its derivation, and avoid spending money on real pesticides (or losing real crops).

Simulations developed and used by APRTC and SDLEARN are available online at the following URLs.

- Crop Production Simulation - http://www.sdlearn.net/APRTC/intro_ipm/popup2_11.asp
- Economic Injury Level Simulator - http://www.sdlearn.net/APRTC/intro_ipm/module2_14.asp?ID=0&OFR=0&CID=3&FNC=0

- Pesticide Resistance Simulator - http://www.sdlearn.net/APRTC/intro_ipm/module2_20.asp?ID=0&OFR=0&CID=3&FNC=0
- Removal of Natural Enemies Simulations - http://www.sdlearn.net/APRTC/intro_ipm/module2_24.asp?ID=0&OFR=0&CID=3&FNC=0
- Pesticide Resurgence Simulator (Hormoligosis) - http://www.sdlearn.net/APRTC/intro_ipm/module2_26.asp?ID=0&OFR=0&CID=3&FNC=0
- Removal of Competitors Simulations - http://www.sdlearn.net/APRTC/intro_ipm/module2_28.asp?ID=0&OFR=0&CID=3&FNC=0
- A Simulated Scouting Game - http://www.sdlearn.net/APRTC/ipm_veg/module3_06.asp?ID=0&OFR=0&CID=6&FNC=0
- How to calibrate a knapsack sprayer - http://www.sdlearn.net/APRTC/responsible_use/popup4_06a.asp

Sustainability

Although not specifically listed as a challenge in the Leary and Berge (2006) paper, one of their key observations dealt with the issue of sustainability. As they note, "Most elearning programs in agriculture currently being undertaken in the world are in the pioneering phase. Services tend to be free and are studies, pilot projects, and other initiatives supported by grants. Many of these projects are not sustainable; after a limited number of training sessions they end when the funding ends, perhaps with a research report published on the Internet and an expectation that individuals can find it, fully accept it, and integrate the findings into training curricula" (Leary and Berge 2006, pp.51-52).

This accurately describes the main challenge faced by both APRTC and SDLEARN and one for which we did not have a good response. Neither of these organizations is currently providing online learning for agriculture. The target audience for the learning courses was not in a position to pay for the courses and it was not possible to interest donor agencies in continuing to fund our learning activities.

RECOMMENDATIONS

Our experience suggests that eLearning has the potential to make an important contribution to international agriculture development. But it is also clear that the widespread adoption of this approach faces a number of challenges. Based on what was learned first hand in the eLearning efforts described above, the authors would like to propose the following actions that they believe will help eLearning in agriculture reach its full potential.

1. Address digital divide issues

Without Internet connectivity, eLearning is impossible. "For e-learning to succeed in the developing world, it needs to build on another important pillar: the existence of infrastructure, along with some degree of connectivity" (Sehrt 2003). As FAO (2005, p.6) notes, "the rural digital divide must be bridged. Otherwise e-agriculture applications will remain beyond reach of rural communities, and will merely exacerbate the existing rural digital divide - leading to an ever-widening knowledge gap between information "haves" and "have-nots".

Addressing connectivity problems is firmly within the mandates of national governments, government institutions and the agencies that support them. This may involve investing in such basic infrastructure as rural electrification. Next is to ensure that rural areas have access to basic and affordable telecommunication service. It is no secret that rural areas are generally much less

likely to receive equitable attention in terms of governance and administration. Unless and until governments improve their service to rural communities, they will constantly be at a disadvantage to their more favored urban counterparts.

One relatively low-cost option is the establishment of rural telecenters. A description of how SDLEARN and its partners took advantage of a national network of 22 Community Information Centers (CICs) in Cambodia can be found in an online DOT-COMments article entitled "A Unique ICT Development Project in Cambodia: Provincial Business e-Learning" (http://dot-com-alliance.com/newsletter/article.php?article_id=141)

Another emerging solution to providing connectivity in rural communities that is both low-cost and designed specifically for agricultural applications is the Fieldserver (http://model.job.affrc.go.jp/FieldServer/FieldServerEn/default.htm). In addition to providing remote scientists with information on temperature, humidity and light intensity it can also provide a wireless LAN environment to an area with diameter of 100m.

But investments in these and other technologies will not happen in countries where the telecommunication sector is highly controlled and monopolistic. Monopolistic services tend to stifle the technological innovation, infrastructure investment and price improvements that often come with competition (Richardson 1997). Where telecommunication reforms have occurred, telecommunication services have "expanded and improved at a faster pace, productivity has increased, new services have become available, and in some cases, international capital markets have been tapped effectively" (Saunders, Warford & Wellenius 1994 quoted in Richardson 1997).

A second and equally important dimension of the digital divide is providing people the knowledge and skills required to take advantage of the new tools and opportunities. Literacy is, of course a key concern. First is the more traditional literacy in terms of being able to read and understand written material. Second, and more specifically related to eLearning, is "Digital Literacy" - "The ability to access and take advantage of networked computer resources and to use and understand information as presented by computers". Marker, McNamara & Wallace(2002, p.16) aptly pointed out that, "Impediments to poor people benefiting from ICTs due to lack of skills can be reduced both by education and training to increase individuals' skills and by developing applications which are adapted to the needs of low skilled or illiterate users".

2. Provide support and training opportunities in online course design and facilitation for agricultural educators

High quality, engaging and relevant online agricultural training courses will not be developed if agricultural educators are not given the necessary skills and practice. They need to be "literate in the new technologies and retrain themselves in pedagogy for them to understand how to make technology support conceptual formation and change in students" (Rapatan 2002 quoted in Bandalaria 2007). Agricultural educators must, "know how to target the audience, consisting of working adults who have limited free time and experience learning online" (Sehrt 2003).

Our experience showed that providing agricultural educators with simple, focused training in online course facilitation worked well, particularly when this training involved coaching and mentoring during the delivery of a real course. This approach has been validated by The National Center To Improve Practice (NCIP), another organization with substantial experience in supporting inexperienced online educators. NCIP takes, "responsibility for responding to technical questions and providing user support and for (1) co-constructing workings with the facilitator (2) modeling and mentoring (3) coaching to prevent and ameliorate problems (4) working in tandem with the facilitator to promote interactivity" (Zorfass et al 1998, pp.8-9).

3. Increase long-term, public-sector, and/or donor support for agricultural eLearning

Expanding electricity and Internet connectivity in rural areas, providing users with basic conventional and computer literacy, and training agricultural educators in how to make the most of eLearning all have substantial cost implications and the required funds must be made available. Given the targets for agricultural eLearning, it is unrealistic to expect the users to bear the costs. After all, the main objective of such efforts is to reduce poverty and raise living standards.

Information for agricultural and rural development was until recently considered a global public good to be made freely available to all, but donors and governments are increasingly relying on private sector delivery. Unfortunately, this sector "is reluctant to cover the cost of developing infrastructure in remote and poor areas, unless forced to do so through regulatory mechanisms or to cover the actual and hidden costs of providing information that empowers poor people, or of gathering, processing and circulating valuable indigenous knowledge"(FAO COAIM II 2002, p.1). Farmers and farmer cooperatives in developing countries could be a particularly important target for subsidized eLearning. They are the ultimate adopters and adaptors of agricultural knowledge yet are the least likely to have the resources required to take advantage of learning opportunities either online or face-to-face.

Governments and/or donors are the only currently viable source of funding for educational efforts targeting rural communities. And, this may well be in society's best interest. If learning is available only to the elite few who can afford it, there is considerable danger that the divide between the rich and poor will not only remain but grow. Winrock (2003, p.22) cautions that while, in general, reliance on the private sector is good, "information and access to it closely resemble a public good threatened with undersupply by market failures." In cash-strapped developing countries, donor support will be critical.

SUMMARY AND CONCLUSIONS

There is little disagreement about the importance of agricultural development in the overall development process. If there is any factor that developing countries share, it is that agriculture accounts for a major share of their Gross Domestic Product and, perhaps more importantly, employment. But agriculture, like most other economic endeavors, is becoming increasingly complex. To meet today's needs, agriculture and those most closely dependent on it, need to change. It is critical that farmers adopt more "knowledge intensive" sustainable farming practices that conserve and replenish natural resources but yet are productive enough to raise the living standards of the poor.

As the term implies, "knowledge intensive" agriculture is dependent on knowledge. Policy makers need to have a thorough understanding of the implications of their actions. Agricultural scientists need to understand and be able to apply ecological principles in the design and development of agricultural technologies. Agricultural educators, including extension agents, need to be conversant in the most appropriate technologies and be able to disseminate and impart these in the most convincing manner. Ultimately, farmers need to be able to evaluate, adopt and adapt new technologies that will best meet their individual changing circumstances without compromising the natural resource base.

A long standing dilemma, particularly in developing countries, has been in how to get important knowledge to those who most need it. Developing country agricultural professionals are largely

isolated from the global knowledge system and poor rural farmers are isolated from national knowledge systems.

An approach that has shown considerable promise, at least for strengthening the knowledge of agricultural professionals who in turn pass knowledge on to farmers, is eLearning. Advantages of this approach for developing countries are clear. eLearning matches the needs of non-traditional students, increases the educational facilities available to traditional students, provides companies with cost-efficient yet effective training options and gives students and researchers in developing nations an invaluable means of gaining a first world education tempered by third world experience.

Even with the accumulation of experience and a growing appreciation of the strength of eLearning for supporting agricultural development, this approach is not being employed in any major way by the leading agricultural development agencies. Only a few small pioneer organizations have tried to test its effectiveness and feasibility for developing countries.

The authors' involvement in two eLearning for agriculture organizations illustrated a number of challenges and discussion provided explanations of steps they took to overcome these. In our experience, while apprehensive at first, most trainers and instructors are quick to grasp the essential requirements of this approach if given a clear, professionally designed course and appropriate orientation and training in online facilitation. Additionally, if these individuals were fairly compensated for their work and did not have to concern themselves with the non-teaching side of eLearning (e.g. marketing, administration), they were enthusiastic and more than competent in fulfilling their roles. While we were not successful in using this approach to reach farmers directly, survey results suggested that by targeting "knowledge intermediaries" we did improve knowledge flow to the ultimate beneficiaries. We also found that the use of computer simulations seemed to address the difficulty of allowing for "hands-on" learning. Unfortunately, the most serious, and in our case fatal, challenge was that of sustaining such efforts in the existing economic and donor environment. Given the limited resources of our target audience (developing country agricultural professionals) and the lack of donor interest in supporting our work, neither of the organizations described is still in operation.

Based on what was learned in these efforts, the authors have advanced 3 recommendations that they believe will help eLearning in agriculture reach its full potential. The first is to address the numerous digital divide issues that plague rural communities. Telecenters and new technologies like the Fieldserver have shown promise. Secondly, we suggest that more attention be paid to providing support and training opportunities in online course design and facilitation for agricultural educators. Without these skills, the development of such courses will be delayed and, when implemented, of poor quality. Finally, we call for increased long-term, public-sector and donor support for agricultural eLearning. To expect for-profit commercial entities to provide the infrastructure and learning required is not realistic. As stated so aptly by Sehrt (2003):

> *If education and capacity-building are critical steps for entering into the new global economy, e-learning should be considered a critical facet of basic development, an alternative medium of capacity-building and a means to people's empowerment.*

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